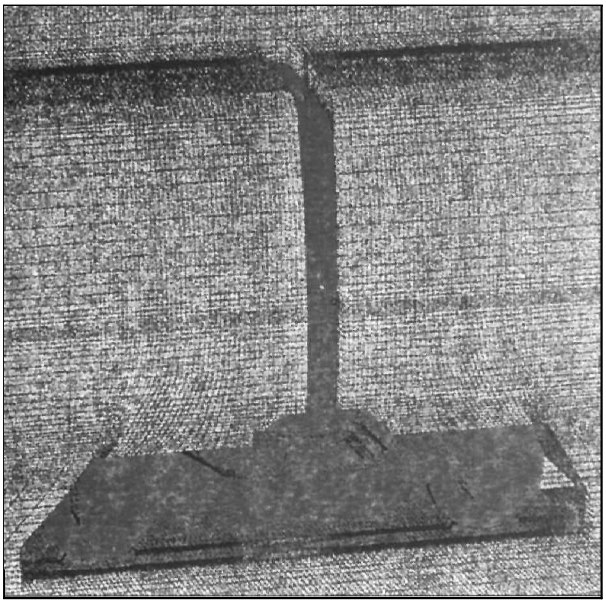
Reducing Aerodynamic Noise from Trains

Over the last 5 years, in-depth studies have been carried out to understand the transmission mechanism of noise passing through doors. Such mechanisms are today understood and efficient solutions have been found which improve the vibro-acoustic behaviour of doors.

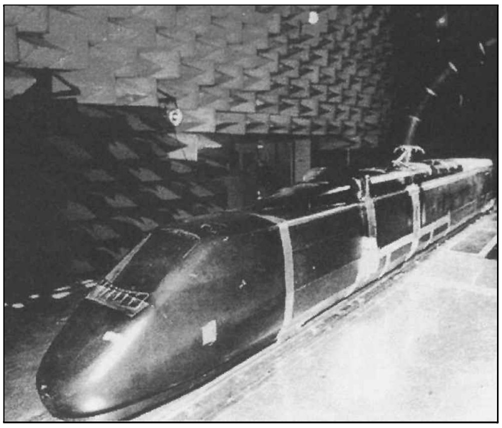
French rail authority SNCF has been researching the reduction of aerodynamic noise caused by high speed trains for some years now. Its aim is to reduce noise levels in the environment while also improving internal acoustic comfort for passengers.

This work is often carried out by SNCF with other European networks, or with industrial groups such as GEC-Alstom. The majority of research projects being carried out call on the expertise of university aerodynamic and acoustic research laboratories. Noise generated by rail traffic is one of the main factors to be considered with new line projects. Train noise comes from two main sources: from the contact of wheel and rail, and aerodynamic noise linked to the air flow around the train.



A 1/7 scale model in an anechoic wind tunnel

Studies have shown that reducing aerodynamic noise is the key to reducing train noise as a whole. The first step in reducing this type of noise consists of correctly identifying the aero-acoustic sources in high speed trains. This can be done by placing acoustic antennae along the track, formed by lines of microphones. The processing of the signals received by such microphones provides a map of acoustic sources in the various frequencies and therefore identifies both the position and type of acoustic source. Specific development has been carried out in order to obtain precise measurements from acoustic antennae when using sources moving at high speed (like TGV trains).



Grid calculation – TGV bogie chassis

The main sources of noise are the pantograph and its cavity, the bogies, the space between carriages, the nose of the train and the slipstream. These sources may be grouped according to the physical phenomena associated with them:

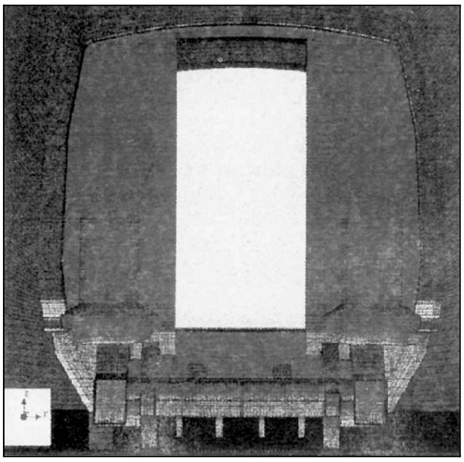
the noise generated by air flows encountering structural elements

- the turbulence created by the pantograph and its equipment
- the cavity noise generated by the pantograph cavity and the gaps between carriages
- the noise due to noise impact and

recirculation under the bogies

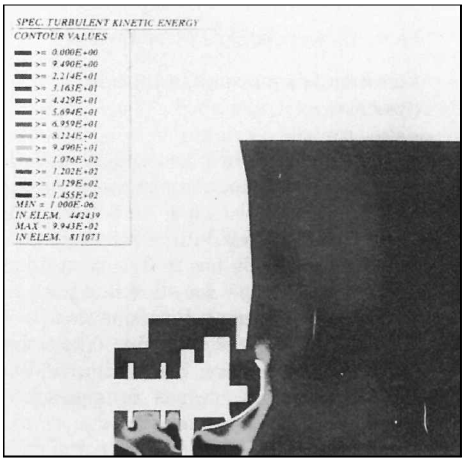
- the noise of ventilators the noise generated by turbulence itself
- the noise associated with the development of a turbulence limit layer on the external surfaces of the train
- the noise associated with boundary layer separation taking place on the nose of the train
- the noise of the slipstream.

The physical phenomena associated with these aerodynamic sources can therefore be of very different origin, and suitable tools are used to characterise such phenomena. These tools are mainly in-line, onboard, trackside or scale model measurements.



Longitudinal section of the grid calculation

This research is carried out between Alstom Transport and SNCF. Acoustic intensity and directivity measurements have enabled efficiency testing of the various streamlining solutions. Digital simulation of three dimensional air flows around the train have also been carried out using specialised aerodynamic software to analyse the influence of geometric streamlining parameters on levels of turbulent fluctuation which generates



Results of aerodynamic digital simulation evaluating a streaming solution

acoustic emissions. This permits an estimate of the potential gains that can be achieved by combining various solutions. These must then be validated at industrial level, quantified in detail and corroborated by track testing. Efficiency in the reduction of aerodynamic noise requires a parallel limiting of noise levels emanating from wheel and track. For future TGV high speed trains, an additional improvement in wheel and track noise of at least 3dB can be expected, compared to the TGV Atlantique, running at similar speed.

For the further acoustic comfort of travellers, Faiveley Transport, in liaison with the SNCF, is working to limit the transmission of external noise to the interior of carriages via access doors. These doors are particularly studied so as not to disturb the air flow along the length of the train (windows and sashes flush with the carriage body, retractable steps). The pantographs are designed to better integrate into their roof environment (the pantograph and its roof streamlining have been tested in an anechoic wind tunnel).

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For more Information

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COSMIC BOOM

Scientists have heard an echo of the Big Bang, the start of the universe. The vast ripples of matter left in the wake of creation an estimated 12 billion years ago were found by a team from Carnegie Mellon University and the University of Maine. These "acoustic oscillations" are akin to the effect of raindrops falling on a pond. "It is fair to say that this is the deepest boom ever observed," said Dr Christopher Miller, lead author of the paper, published in Science. "A true echo of the Big Bang is a good way to look at it," he said. This is the first published evidence that links the existence of acoustic oscillations, or wiggles, in the distribution of both the microwave radiation and the matter throughout the universe. These acoustic "waves" were first found in the cosmic microwave background radiation, generated when the cosmos was a mere 300,000 years old. "Now, with the discovery of these oscillations in the matter, we have a direct connection between the universe today and the universe as it was over 10 billion years ago," said Dr Miller.